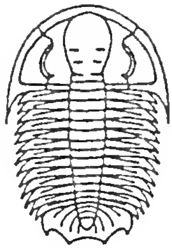
THE FOSSIL COLLECTOR



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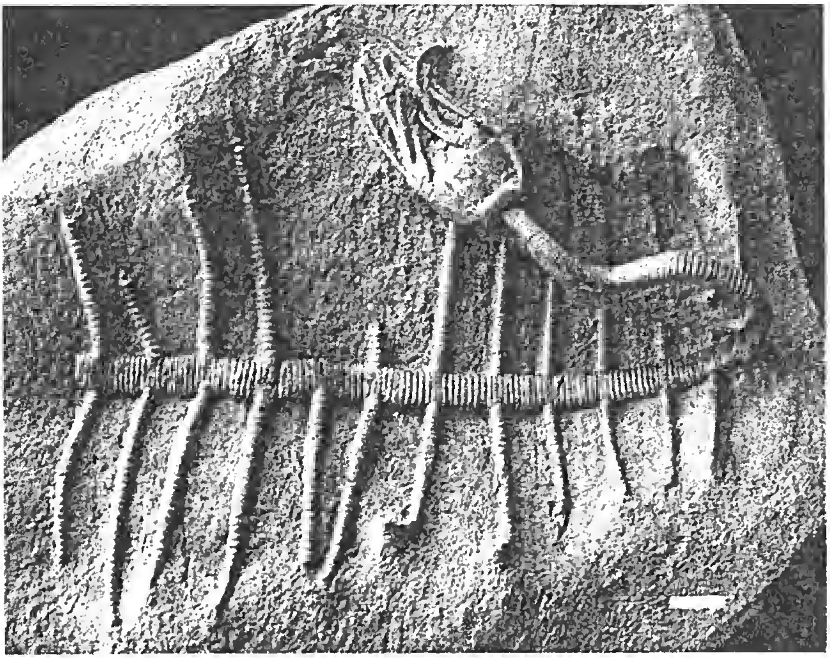

Neocamptocrinus sp. Early Permian (Late Artinskian), Cundlego Formation, Gascoyne District, northwest Western Australia. Photograph, courtesy Chris Ah Yee. Scale bar 1 cm.

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THE FOSSIL COLLECTORS' ASSOCIATION OF AUSTRALASIA

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EDITORIAL NOTES

Before I start on this issue's Editorial Notes, I would sincerely like to thank Frank Holmes for putting together the last issue of *The Fossil Collector* and also his support over the past 12 months or so. I would also like to thank all those people who have written or phoned to give me their best wishes, I truly do appreciate it. While it has been a long recovery period after the crash, I am happy to say that I'm pretty much back on deck again and things are progressing well. I am hopeful that I will be walking without crutches in the next month or so.

On the fossil front, now that I am more mobile again (yes this means I can drive), things that were on hold are now starting back up again. The first cab off the rank is the re-commencement of the Triassic insect project which has been waiting for so long now. It is also now time to catalogue and properly identify those fossils I have been buying while I was incapacitated (I have to find someway to collect). Amber has taken my interest of late and I have managed to acquire some very nice specimens of Dominican, Baltic and Columbian amber, all with insects (of course).

My palaeontological library has also done quite well during my down time. Four books which I have been particularly impressed with are *Fossil Crinoids*, *The Trilobites of New York*, *The Fossils of Florissant* and *Dinosaurs and other Mesozoic Reptiles of California*. No Australian titles, but the 4 books mentioned above do give a very detailed and in depth account of their respective subjects and they have a lot of very nice pictures.

Please not that my address and telephone number have changed, my new contact details are on page 2 of this issue. With moving I have become very much aware of how we humans expand to fill the available living space we have. I have moved into a somewhat smaller house and I just didn't realise how much rock I have collected over the past 9 years, and I am very selective as to what I pick up and take home. The result of this is that my new house has a double garage which is full of things other than a car. My problem is that I'm also a hoarder and when someone suggests I get rid of some of my 'stuff', well, I do go a little pale.

As this is the last issue for 2004, I would like to take this opportunity to wish all readers and their families a very safe and happy festive season and here's looking to a better and happier 2005.

FOSSIL PROTECTION IN SOUTH AUSTRALIA

The Department for Environment and Heritage and the Department of Primary Industries and Resources SA (PIRSA) have prepared a Discussion Paper on options for the protection of fossils in South Australia. Members of the public are now invited to comment on the issues raised and to make a written submission in response to a number of specific questions outlined in the Discussion Paper.

All submissions will be considered in developing recommendations for the protection of fossils. While this will be of considerable interest to our South Australian subscribers, any new or altered legislation will affect all collectors, directly or indirectly, particularly if other States that currently have little or no legislation specifically covering the collection of fossils, take similar action in the future.

Copies of the Discussion Paper can be downloaded from **www.minerals.pir.sa.gov.au** by typing FOSSIL PROTECTION in the Search Box of PIRSA Minerals Home Page and then left clicking "Fossil Protection in South Australia (2KB)". Alternatively, Hard Copies of the Discussion paper are available from the Department of Environment and Heritage, Reception Area, Ground Floor, 1 Richmond Road, Keswick SA or from the Department of Primary Industries and Resources SA, Reception Area, Ground Floor, 101 Grenfell Street, Adelaide, South Australia. Enquiries may be directed by telephone to (08) 8124 4718 or (08) 8463 3183.

Submissions are to be sent to Dr. Bob Inns, Manager Land Management, Department of Environment and Heritage, GPO Box 1047, Adelaide, SA 5001, by **8 November 2004** .

While a submission will be made on behalf of the Association, we strongly recommend as many of you as possible make individual submissions. The Discussion Paper incorporates a series of 16 questions with adequate space for comments.

One very interesting note in the Discussion Paper, relates to the current state of ownership of fossils in South Australia:

> "The Crown is the owner of fossils in South Australia, including fossils found on pastoral or perpetual leasehold lands and lands subject to Native Title, by virtue of the Mining Act 1971, whereby fossils being either composed of stone or are a stone (as that term is defined in various dictionaries), fall within the definition of minerals."

Frank Holmes, Secretary

WHAT'S IN A NAME?

The Problems of Zoological Nomenclature.

Compiled by Frank Holmes

Introduction

In the mid-eighteenth century the Swedish biologist Carl Gustav Linnaeus (1707-78) resolved confusion in the naming of animals (and plants) by devising a binomial or 'two name' system to be applied to every known species, living or extinct. The zoological and botanical communities acceptance of the Linnaean system of classification, which continues to be used today - though greatly modified and extended, successfully averted the first bio-information crisis.

However, by the end of the nineteenth century, after an age of widespread exploration and discovery, it became clear that despite adherence to the Linnean system, chaos was imminent. No rules existed to prevent zoologists in different parts of the world from giving the same names to different animals, or indeed different names to the same animal.

International Commission on Zoological Nomenclature

Without an organisation to control the naming of animals, widespread confusion was a real threat. To overcome this problem the zoological community established the International Commission on Zoological Nomenclature (ICZN) in 1895 to provide rules and processes to resolve arguments about the validity of names. Today, the Commission's *International Code of Zoological Nomenclature* provides the foundation for Zoological taxonomy and the clarification and use of animal names in areas as diverse as endangered species, disease carriers, food and domestic animals, pets, fossils, and species of particular interest to evolutionary biologists and the petrochemical industry. Fossil plants are subject to the *International Code of Botanical Nomenclature* which contains minor differences in the treatment of names.

Binomial Nomenclature

In his *Systema Naturae*, published in 1758, Linnaeus required each species (which can be broadly defined as individuals that generally look alike and can interbreed to produce offspring of the same kind) to be

given two names: a generic name and a specific (or trivial) name. Naturally with fossils it can never be known for certain whether a population of animals with a particular morphology was reproductively isolated or not: consequently, the definition of a fossil species or subspecies, as indeed is often the case with living organisms, must be based almost entirely on morphological criteria. Taxonomic categories above the level of species (genus, family, order, class, phyla etc.) are to some extent artificial and subjective but as far as possible reflect evolutionary relationships.

The specific name, the smallest unit of division in common use today, is always written with a small (lower case) first letter. Obviously, this name can be used only once when associated with a particular genus but any number of times if linked to different generic names. As an example, the echinoid bi-nomen *Monostychia australis* is unique, although there are many other genera that have "*australis*" as a specific name, such as the brachiopod *Protochonetes australis*, the bivalve *Unio australis* and the graptolite *Stomatograptus australis*. As a further example, the palaeontology index of the 1988 edition of the Geology of Victoria lists 17 genera linked to this specific name. A subspecies name, now less commonly used in palaeontological literature than in the past, succeeds the species-group name to form a trinomen and follows the same basic rules of nomenclature (a subspecies is an interbreeding natural population differing taxonomically, in respect to gene pool characteristics, and often isolated geographically from other similar groups within a biological species; and where the range of individual groups overlap they can interbreed successfully).

On the other hand, the generic name (e.g. *Monostychia*) can be used only once irrespective of the higher taxonomic categories, such as the family, to which it has been assigned by its author - the person who first described its particular morphological characteristics. As noted above, generic names refer to arbitrary units that incorporate one or more closely related species which have similar features and, unlike specific names, are always written with a capital (upper case) first letter. A subgeneric name (given to a subdivision of a genus) follows the same basic rules of nomenclature as apply to a generic-group name. However, the name is enclosed in parenthesis and is placed between the generic and specific names.

Generic, subgeneric, specific and subspecific names are always written in *italics*, **bold type** or with individual names underlined, the former being the most common.

There are tens of millions of living species on earth (mostly animals) yet to be described and named. How many more fossil species will be discovered is anyone's guess.

While choosing a specific name is relatively simple (you only have a single genus to check to find if the name has been previously used), searching the tens of thousands of generic names published in the world's zoological literature over two hundred and fifty years or so, would seem a be a daunting task; even with the help of books and articles listing generic names currently used in a specific area of research (e.g. trilobites). Luckily there are two major ongoing publications that, amongst a wealth of other information, include generic names. A third, and probably the most valuable source of all, is a series of volumes specifically listing generic and sub-generic names in use. Unfortunately, these latter volumes are published in a ten-year cycle [see below for reference to *Nomenclator Zoologicus*].

The Zoological Record (ZR) – published by Thomson BIOSIS

The Zoological Record is the world's oldest continuing database of animal biology. Its coverage, extending back to 1864, has long acted as the world's unofficial register of animal names. However, this is only one aspect of the *Zoological Record*, as its coverage represents every area of animal biology from biodiversity and the environment to taxonomy and veterinary sciences.

While the 4,500 or more serials regularly viewed generate a significant portion of the records indexed in the database, *ZR* contains many other sources of information, including books, reports, and meetings, which together result in the addition of about 72,000 indexed records each year and a 1.5 million record archive available in electronic format.

BIOSIS also sponsors and hosts the *Index to Organism Names* which incorporates name data from its own resources and several other collaborating organizations. It is maintained in the UK by staff of the *Zoological Record* and the Zoological Society of London. This index currently covers animals (all names reported in *ZR* since 1978) including

those protists generally considered animals, i.e: algae, bacteria, fungi, and mosses. The name index constitutes a publicly available subset of *TRITON*, the *Taxonomy Resource and Index To Organism Names,* an 'in development' system and precursor of a possible future subscription-based service. Print, CD and online formats of the *Zoological Record* are available by subscription, but a wealth of general information,. including a *Nomenclature glossary for Zoology*, and a *Zoological Record Serials List*, can be found on the Thompson BIOSIS web site: **www.biosis.org/.....** The *Index to Organism Names* is best approached via **www.biologybrowser.org/** Home page, then clicking the *Search the Index to.....* box at the bottom right of the screen.

The Treatise on Invertebrate Paleontology **– published by The University of Kansas and The Geological Society of America, Inc.**

Apart from general characteristics and information on morphology, function, reproduction, ontogeny, phylogeny and evolution etc., each part of the Treatise lists the classification and systematic description of taxa down to the level of genus. Listed after each generic name are details of synonymy, a brief description of morphology, geological time range, world distribution and nearly always an illustration. Over the last 50 years, 20 parts (often containing more than one volume) have been published, each individually indexed and covering a separate phylum or subject. Even though many parts have been revised or are in the process of revision, by its very nature the Treatise will, to some degree, always be out of date.

As an example of this problem, Jell and Adrian (2003) published a list of more than 5,000 trilobite generic names from 180 families in use at the time their manuscript was submitted. By comparison *The Treatise on Invertebrate Paleontology (Part O, Arthropoda 1)* published in 1959 only lists about 1,200 genera and so far only a single volume of the revision (1997) is available .Web site: **www.ukans.edu/~paleo. treatise**

Nomenclator zoologicus **– published by the Zoological Society of London.**

This publication covers generic and sub-generic names used since Linnaeaus' *Systema Naturae* was published. It currently consists of 9

volumes; vol's 1 to 4 (published in 1939/40, each covering part of the alphabetical listing of names used between 1758-1935) & vol. 5 (1936-1945), S. A. Neave, ed.; vol. 6 (1945-1955), M. A. Edwards & H. G. Hopwood, eds; vol. 7 (1956-1965), M. A. Edwards & H. G. Vevers, eds; vol. 8 (1966-1977), M. A. Edwards & M. A. Tobias, eds; and vol. 9 (1978-1994), M. A. Edwards, P. Manly & M. A. Tobias, eds. All you have to do is find a library that has all the volumes.

Composition of words

To the layperson, the composition of zoological or botanical names may seem quite complicated, particularly since so few of us have been taught any Latin or Greek at school. However, with the aid of books, such as *Composition of Scientific Words* by W. B. Brown (first published in 1927 under the title *Materials for word study*) you can begin to compose a suitable generic or specific name. Nevertheless, if your grammatical skills are not the best, it is advisable to have someone check your proposed name(s), particularly in relation to gender and the use of affixes etc. While the use of Latin or Greek words as the basis of scientific names is traditional, there is no basic restriction on the use of any arbitrary combination of names or letters. A good example of this is the specific name of an Australian echinoid *Apoxypetalum chenjafra*, a combination of the first letters of four given names: Chris, Enid, Janise and Frank. The use of a place or person's name by its own or in conjunction with other terms is quite common; e.g. *Baragwanathia*, a Siluro/Denvonian plant named after W. Baragwanath, Director of The Geological Survey of Victoria (1920-1943); or *Gogonasus*, an osteolepidid fish from Gogo, northwest Western Australia. It is often jokingly said that the hardest part of describing a new genus and species is selecting suitable names. To this end, keeping a name reasonably short and pronounceable is half the battle.

Prefixes & suffixes

Root-stem words are often modified by the addition of prefixes and/or suffixes, a process sometimes called derivation. Examples of common prefixes are *mega-* [Gk *megas*] large, great; *pre-* [L. *prae*] before, very; *pseudo-* [Gk *pseudes*] false; and those related to numbers e.g. *bi-*, *tri-*, *quad-* (or *tetra-*), *pent-*, etc. Suffixes often seen at the end of specific names include, *-oides* like, resembling, having the form of; and *-ensis* denoting place, locality, country. Suffixes are also added where modern

personal names are used e.g. *-i* if the name is of a man, *-orum* if of men or man (men) and woman (women) together, *-ae* if of a woman and, *-arum* if of women [International Code of Zoological Nomenclature, Article 31.1.2.A, 4th Edition, 1999]. In zoology the most recognised suffixes are probably those used to denote taxonomic categories such as *-inae* Subfamily, *-idae* Family, *-ida* Order, *-idea* Class etc.]

Open Nomenclature

The procedure by which a taxonomist comments upon the identity of a specimen that cannot be readily or confidently determined. Uncertainty of the provisional status of a taxonomic identification may be expressed in prose, such as 'probably *Agenus aspecies*', but is more often codified through the use of qualifiers such as **aff.** (*affinis*), **cf.** (confer), or **?**. The following details given by Bengtson (1988), indicate the usage and meanings generally used by palaeontologists.

aff. (or **sp. nov., aff.**) proceeding a species-group name indicates the specimen(s) is considered a new, previously undescribed species (or subspecies). The material is insufficient for formal description and naming of a new taxon, but the specimen(s) can be most closely related to the species or (subspecies) following the qualifier, e.g.

Monostychia sp. nov., aff. *australis* Laube, 1869

'...' (i.e. quotation marks) around a genus-group name indicates that the species is thought to belong to a new genus (or subgenus) related to the named genus, but the material available is insufficient for the formal erection of a new genus. However, these quotation marks [usually in a text reference rather than in systematic taxonomy] are more often used to indicate the name is not the right one but the author is not sure what is correct, e.g.

'*Sismondia*' *murravica* Tate, 1893

cf. proceeding a species-group name indicates that the determination is uncertain, probably due to the poor preservation of the material, e.g.

Eupatagus cf. *rotundas* Duncan, 1877

? overlaps partly in usage with **cf.**, although the former is less frequently used for provisional determinations. The **?** is more likely to be used after a genus-group name, where the lack of some diagnostic

detail on the specimen(s) and/or the specific age differs markedly from other known occurrences of the genus, thus raising a degree of uncertainty, albeit small e.g.

Aphanopora? *bassoris* Holmes, 1995

sp. (species, singular) and **spp.** (species, plural) indicates that the specimen cannot be related to any established species (or subspecies) or that specific identification has not (yet) been attempted, e.g.

Echinolampas sp.

Other less commonly used expressions such as **sp. indet.**, **sp. 'A'** etc. are in most cases self-explanatory. Where neither the genus or species can be determined, **indet.** (*indeterminata*) is normally placed after the name of the family or higher taxonomic category, e.g.

Faujaciid indet. [for a specimen belonging to the Faujaciidae family].

Authorship

In systematic palaeontology the name of the author and year of publication follow the taxon name. This applies to the whole range of taxa (species, genus, family etc.). As the species name is linked to the generic name (bi-nomen), the name that follows the bi-nomen refers only to the author of the species, e.g.

Clypeaster gippslandicus McCoy, 1879

The above bi-nomen would probably be preceded by the generic and higher taxon names with their respective authors. In this case:

Order CLYPEASTEROIDA A. Agassiz, 1872
Family CLYPEASTERIDAE L. Agassiz, 1835
Genus *Clypeaster* Lamarck, 1801

The author's name and year are placed in parentheses if the generic name now being used differs from that used with the original description (species re-assigned), e.g.

Australanthus florescens (Gregory, 1890) – Gregory originally placed '*florescens*' in the genus *Cassidulus*.

The author's name, year and abbreviations (such as sp. nov. etc.), unlike the taxonomic names, are not written in italics. In most journals, only the first citation of a species (bi-nomen) includes the author's name and year.

When another author's work is quoted in a text, the name and year of publication (and sometimes the reference page number) are placed in parentheses, e.g. ..... (Jones 1990), or ..... (Jones 1990: 137). In these instances (depending on editorial style) the comma separating the name and year is usually omitted. When a comment is made relating to an author's work, only the date is parenthesised, e.g. Jones (1990) considered ..... or ..... considered by Jones (1990).

Abbreviations

Latin is traditionally the language of science and as a result the use of Latin terms and abbreviations in palaeontological literature is virtually universal. Nevertheless, the many different terms and abbreviations used can be confusing to those not familiar with them. The following (excluding those previously mentioned in open nomenclature) is a list of the more common forms likely to be encountered.

ca (*circa*) – about, with reference to time.
cit. (*citatus*) – cited.
emend. (*emendatio*) – emended. Used if the understanding of a species, genus, family etc., is substantially emended from the original proposal.
et al. (*et alia*) – and others. Used in references to indicate multiple authors.
ex gr. (*ex grupo*) – from (belonging to) the group of.
fide (*fide*) – on the authority of, with reference to a published statement.
fil. (*fillius*) – son or daughter. Used to avoid confusion between parent and offspring having the same initials, e.g. Etheridge fil., to distinguish between R. Etheridge Senior and R. Etheridge Junior, who were both publishing at the same time.
gen. et sp. nov. (*genus novum et species nova*) – new genus and species.
gen. nov. (*genus novum*) – new genus.
hom. (*homonymum*) – homonym, each of two or more identical but independently proposed names for the same or different taxa: junior homonym – later published of two homonyms (a preoccupied name); senior homonym – earlier published of two homonyms.
ibid. (*ibidem*) – the same reference (journal or volume) as listed in the preceding item.
in litt. (*in litteris*) – in correspondence.

loc. cit. (*loco citato*) – place cited (publication and paper), compared with op. cit., in which only the publication is cited.
nom. nov. (*nomen novum*) – a new name to replace an invalid name.
nom. nud. (*nomen nudum*) – an invalid name with no definition or description.
non (*non*) – not, e.g. *Echinolampas duncani* Cotteau, 1891 (non McNamara, 1987), i.e. *E. duncani* of Cotteau not McNamara.
part. (*partim*) – part. Used mainly in synonymy to indicate only part of a previous author's listed specimens are now considered attributable to the species being described.
p.p. (*pro parte*) – in part, partly.
s.l. (*sensu lato*) – in the broad sense.
s. s. (*sensu stricto*) – in the strict sense.
sic. (*sic*) – as used, spelt etc. Used in citations (in parentheses), after a printed word or number, to confirm an error is intended or that it represents an exact quotation of the original.
sp. nov. (*species nova*) – a new species.
subgen. or sub. gen. – subgenus.
ssp., subsp. or sub. sp. – subspecies.
syn. (*synonym*) – synonym, each of two or more different scientific names applied to one and the same taxon: junior synonym – the later published of the two or more different names; senior synonym – the earliest published of the two or more different names.

Source material

Abbreviations and Latin terms used in palaeontology: Neil Archbold. *The Fossil Collector*, May 1983.

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THE ANCIENT CONIFERS AND GREAT LAKES OF BASS STRAIT

The following is a summary of a talk given to the Geology Group of the Field Naturalists Club of Victoria by Dr Alan Partridge, a specialist in palynology (the study of fossil spores and pollen). We wish to thank Dr Partridge and the F.N.C.V. for permission to reprint the summary contained in *Field Nats News* No.134, August 2004.

The Wollemi Pine was discovered in Wollemi National Park, NSW in 1994. A member of the family Araucariaceae, the new genus and species *Wollemia nobilis* Jones, Hill and Allen, 1995, differs from other living members of the family in its pendant foliage and branches, and particularly in the 'bubbly' texture of its bark as compared to the flaky bark of the kauri pines like *Agathis*.

Although the fossil record of the Family Araucariaceae extends back some 200 million years into the Jurassic Era, the fossil record of pollen from the Wollemi Pine only extends back to the mid-Cretaceous Turonian Stage, or about 90 million years. These fossil pollens were first discovered in 1965 in the Dilwyn Formation at Port Campbell, Victoria, and subsequently described by Harris (1965) as *Dilwynites granulatus*. This is the same year in which commercial hydrocarbons were first discovered in the offshore Gippsland Basin. Since then the pollen has been found widely distributed in the sedimentary rocks, especially those laid down in large or giant lakes that have been penetrated by exploration wells in the Gippsland and Otway basins.

It is important to consider how pollen enters the fossil record and be able to use it in the interpretation of ancient environments. The pollen of the Wollemi Pine is initially distributed by the wind. On a geological timescale this is a very ephemeral event, and the pollen is quickly washed out of the atmosphere (via rain or fallout). Thereafter the pollen becomes sedimentary particles of clay size to be distributed by water to their ultimate burial in sediments as fossils. In interpreting the abundance of pollen recovered from sedimentary rocks it is necessary to stress the importance of the Neves Effect, an empirical observation as to how the ratios of pollen types vary with distance from their source. The hinterland of a landmass represents the largest areal source of pollen, while by contrast the deltaic and shoreline vegetation within a basin occupy a relatively small area. Consequently, as samples are taken from sediments at intervals progressively further from land, the pollen from deltaic and shoreline species declines fairly rapidly in both absolute and relative abundance. However, those pollens from the hinterland vegetation

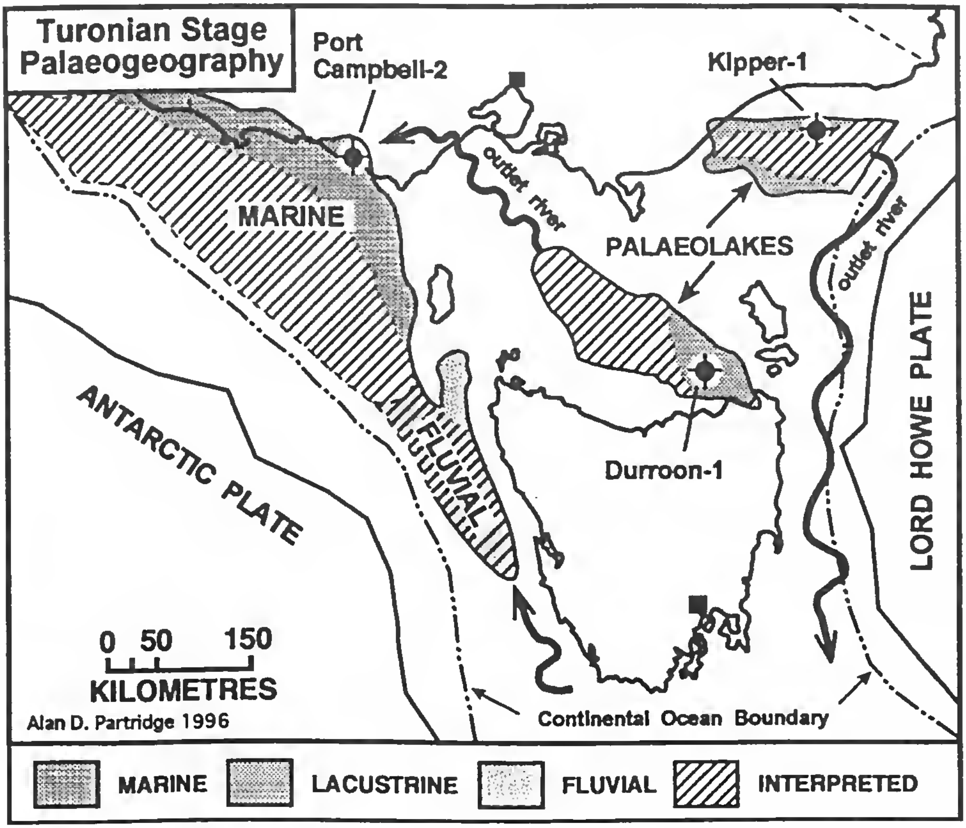

Figure 1. Palaeogeographic map of Bass Strait during the Turonian Stage of the Late Cretaceous (ca.~90 million years) before the final break-up of Gondwana. The Antarctic continental block was not too far south of Victoria and the Lord Howe Rise (the northerly extension of New Zealand) was located off the east coast of Australia. Large fresh water lakes formed in the Gippsland and Bass Basins in response to the tectonic collapse in these areas during the early phase of the break-up. At the same time a marine transgression entered the Otway Basin from the west, but does not appear to have reached the Sorrel Basin (off the west coast of Tasmania) which has non-marine fluvial (to deltaic?) environments. The courses of the outlet rivers shown are hypothetical, but there must have been rivers created by the overflow from the lakes at that time because the high palaeolatitude meant that rainfall and runoff would have exceeded any loss by evaporation (as compared to say the present day Lake Eyre). The diagonally hatched areas marked "Interpreted" refer to the inferred distribution of sediments based on geophysics (seismic data). As in the areas concerned the sediments of Turonian age are too deep to be intersected by exploration drilling.

decline in absolute abundance more slowly. This creates the situation where those fossil assemblages that are furthest from the shore, tend to be dominated by the pollen of plant species more representative of the hinterland vegetation. Using data from the Roundhead-1 exploration well in the East Gippsland Bass Strait, it was shown that high relative abundances of *Dilwynites* pollen coincide with high abundances of marine microplankton; indicating the ancient version of the Wollemi Pine was a major component of the hinterland forests. This is probably true for most of the Araucarian forest during the age of the dinosaurs.

Observations on the distribution of the Neves Effect [mentioned above] can be used to identify past giant lakes in the sedimentary basins under Bass Strait. The oldest lakes are Turonian (early Late Cretaceous) when Australia was still part of the larger Gondwana. Australia had not yet separated from Antarctica to the south and the Lord Howe Rise to the east (now a submerged continental block in the Tasman Sea). The early rifting events, part of the break-up of the super-continent, is characterised by the giant palaeolake Durroon in the Bass Basin between Victoria and Tasmania and the giant palaeolake Kipper in the Gippsland Basin (Fig.1). These lakes were respectively 7,500 sq. km. And 15,000 sq. km. In size, which in today's terms would rank them within the 25 largest lakes in the world. Sediments deposited in the middle of these lakes show strong Neves Effect with high abundances of *Dilwynites* pollen and endemic suites of non-marine lacustrine phytoplankton; indicating that the lakes persisted through a significant length of geological time and were probably fairly deep.

With further break-up in the Late Cretaceous and formation of new oceanic crust to the south and east of Australia, the Gippsland Basin became a marine continental margin basin. However, the Bass Basin remained landlocked and giant lakes persisted there through the late Cretaceous and early Tertiary. The palaeolake Koorkah, which formed in the northern portion of the Bass Basin between the Maastrichtian and Early Eocene, started out as fresh-water but became a marine coastal lagoon from the latest Paleocene when marine waters penetrated the basin, either around the north of the Otway Ranges or through the strait between the Otway Ranges and King Island. Palaeolake Kookah was shallower than the earlier palaeolake Durroon as there are records in some wells indicating the lake drained (or

severely contracting in size) and the lake floor being covered with fern meadows. In the palynological record these are represented by spikes showing an abundance of Gleicheniaceae (coral & fan ferns) spores.

The ancient hinterland forest, dominated by the ancestors of the Wollemi Pine, also display an interesting inverse relationship to the *Nothofagus* dominated rainforest that characterise so much of the Australian Tertiary vegetation history. The dominance of *Dilywnites* as the most prominent hinterland pollen type is replaced by fossil *Nothofagus* pollen in the younger Campanian and Maastrichtian stages of the Late Cretaceous. *Dilwynites* pollen rises to prominence again in the Paleocene and Early Eocene part of the early Tertiary, before being relegated to a minor part of he overall rainforest vegetation from the Middle Eocene to Late Miocene when *Nothofagus* again dominated. This inverse relationship may be a consequence of the 'End Cretaceous Event' which knocked out insect, bird and animal pollinators of the angiosperms, allowing wind-pollinated gymnosperm plants to make a brief comeback during the Paleocene while mammalian and other faunas evolved to fill all available niches.

In conclusion, it seems that the Wollemi Pine, though now confined to a single valley in NSW, once constituted the major part of the vegetation of southeastern Australia and has an interesting story to tell about the history of the geology and vegetation of the region.

Summary by Clem Earp

IN THE NEWS

Oldest Hummingbird Fossils Found

A pair of 30 million year old fossils from southern Germany are the oldest fossil hummingbirds, a researcher says. The location of the finds is unexpected, because today the birds are only known from the Americas. In the May edition of *Science* magazine, Dr Gerald Mayr, of the Senkenberg Natural History Museum in Frankfurt, claims the fossils show many striking resemblances to modern hummingbird groups. The extinct hummingbirds may have influenced the shape of some modern Asian and African flowers.

Fossils of primitive hummingbirds have been found in the Old World before, but it was a great surprise to find a bird that looked so similar to the modern hummingbirds. Other fossil hummingbirds have been found in Central America, Europe and Asia, but they are either very different from modern ones or are known from just a few bones. The new fossils, which have been assigned to the species *Eurotrochilus inexpectatus*, were endowed with long, nectar-sucking beaks and wings designed for feeding while hovering. They share key anatomical features on their wings with modern hummingbirds. The primitive hummingbird *Jungornis tesselatus* lacks these features. This suggests that *Eurotrochilus* and modern hummingbirds belong together in a distinct group of birds, while *Jungornis* belongs to another, more primitive group.

Hummingbirds used to have a much wider distribution but, for some reason, they became extinct in the Old World. Dr Mayr has no idea what caused this extinction, although Professor Ethan Temeles, of Amherst College in Massachusetts, USA, speculated that the extinction could have been caused by climate change. Considering the small size of hummingbirds, if there were climatic changes, this might have been the responsible factor. Professor Temeles also said that competition between hummingbirds and other nectar-feeding birds might have been a factor.

Extinct hummingbirds might also have helped determine the shape of some modern Asian and African flowers through a back-and-forth evolutionary process called co-evolution. These plants may include the species *Canarina eminii*, *Impatiens sakeriana* and *Agapetes*. An example of this is the North American species of *Impatiens*; it has a very long floral tube that's shaped like a trumpet, ending in a nectar tube or spur. The nectar-containing spur associates with the hummingbird beak to some extent, though not perfectly. At the same time, they contain petals around the flower, which suggests they provide a landing platform for bees. Botanists now have to look at plants in the Old World to see if any of them show evidence of co-evolving with hummingbirds.

Summary of story from BBC News Online, May 6, 2004.

Ancient Arthropod Caught Moulting

Arthropods were moulting to make room for growth more than 500

million years ago, fossil evidence confirms. Scientists have long believed these creatures shed their hard, outer layers, just like their modern counterparts - such as insects - do today. Now, the journal *Nature* reports the discovery of the first fossilised creature to actually be caught in the act of shedding its exoskeleton. The Cambrian arthropod was found in the famous Burgess Shale, Canada.

Exoskeletons are the most common body arrangement among Earth's animals. Insects and crustaceans have them, while mammals, birds and fish have endoskeletons. An exoskeleton provides a hard casing that offers some protection from predators. But there is a downside: it does not allow the body to expand. If an animal sporting an exoskeleton wants to grow, it must dump it temporarily before forming another, in a larger size.

Scientists have suspected that the strategy of moulting (ecdysis) has been around since the first arthropod - about 545 million years ago - or even longer. They have been supported in this belief by circumstantial evidence. For example, a few fossil trilobite specimens were found in what looked like a post-moult state. But until now, there was no direct proof that Cambrian arthropods moulted. The specimen that cleared the matter up, a 505 million year old creature known as *Marrella splendens*, was perfectly preserved in mid-ecdysis. It is described in *Nature* by researchers Diego García-Bellido and Desmond Collins.

Dr Collins, from the Royal Ontario Museum, confirmed that the discovery of an arthropod in the act of moulting was exciting because it was so unexpected. Sometimes, specimens of trilobites and other fossil arthropods are found that look like they could have been moults, but researchers just couldn't be sure. With the new specimen, all doubt has been removed.

There are two main reasons why the fossil record has, until now, been reluctant to provide such evidence. Firstly, a creature in moult has a soft body, which does not preserve easily - the conditions have to be just right. And secondly, the process of moulting is usually very quick; meaning the "window of fossil opportunity" is small. The likelihood of capturing such an event is astronomically small, similar moulting events in living arthropods, such as larval lobsters take less than 10 minutes. It would also take a large sample size to find such a specimen, 25,000 *Marrella* specimens have been collected so far, and in a fossil assemblage that preserves soft-bodied animals.

Summary of story from BBC News Online, May 6, 2004.

Past Predators not Found Wanting

Australia's ancient lands had their fair share of big, fierce carnivores, a Sydney team of researchers argues. It has been a popular theory of the last 10 years that poor soils had acted to restrict the size and diversity of the country's warm-blooded predators. But Stephen Wroe , from the University of Sydney's School of Biological Sciences, and colleagues have compared Australia and South America over 25 million years to show this stunted view of history is a myth.

They cite examples such as the presence of killer kangaroos, marsupial lions and other predators in Australia's past, including 13 kinds of Tasmanian "tiger"; which given its size and isolation suggests Australia did pretty well for large mammalian carnivores. In addition new fossil discoveries are steadily extending the list of known species.

It was a 1994 book, *The Future Eaters*, which popularised the idea that the apparently low numbers and small sizes of Australia's mammals could be attributed to a lack of food. It was claimed the continent's nutrient-poor soils restricted plant growth, which led to smaller herbivores and impeded the growth of the carnivores that fed on them. The theory was appealing and intuitive, but it was never really backed up by hard quantitative science.

Wroe's team tested the idea by examining a "great natural experiment" - the period of isolation South America experienced before it crashed into North America three million years ago. For tens of millions of years, the southern landmass had conditions not dissimilar to those in Australia and both were dominated by a spectacular and bizarre range of predatory marsupials. South America, for example, had a marsupial sabre-tooth, an animal the size of a jaguar, but with fangs up to 15cm long. The Sydney team has reported that the diversity and size of the meat-eaters on the two landmasses were broadly the same for 22 million years. The picture only changes when the American continents are joined and new predators move south from North America.

However, it is the Sydney team's assessment of the available data that Australia has had the sort of diversity of large warm-blooded carnivores one would expect for a continent of its relatively small size and isolation. Indeed, when compared with many other continents, it

may even have done slightly better than expected. Over the last 65,000 years, only around 45 species of warm-blooded carnivores exceeding even 2.5 kg have existed on the entire planet. Despite only amounting to around 6% of the world's land surface area, more than 10% of these were big, furry, sharp-toothed Australians that packed a helluva punch.

The Future Eaters, written by Dr. Tim Flannery, director of the South Australian Museum in Adelaide, has become a popular and influential description of the Australia's past and was turned into a major ABC TV documentary. Dr. Flannery told BBC News Online that the Wroe team's analysis contained interesting data but failed, in his view, to unseat impoverished soils as the "fundamental driver behind change in evolutionary trajectories". Flannery argues that the database he drew on to make his hypothesis was a very broad one, it included the responses of Australian plants; it drew on the behaviour of birds; it drew on the lifecycles and physiology of some of the marsupials. And it noted that in the carnivore guilds of Australia, there was only one species in each of the major guilds - the major guilds being dog-like, cat-like and scavenger – whereas overseas it was usual for there to be more than one. To Flannery it appears that on average, the Australian carnivores were rather small for the size of the continent they came from. Dr Flannery said one of his major reservations about the Wroe team analysis was that it had not, as far as he could see, analysed soil values in South America.

Summary of story from BBC News Online, May 10, 2004.

Mass Extinction Crater Pinpointed

Geologists may have finally found the cause of the greatest mass extinction event in the Earth's history: a gigantic meteorite impact that slammed down 250 million years ago at a location called Bedout in what is now the Indian Ocean. Robert Poreda, a geochemist from the University of Rochester U.S.A. and a member of the team that published a paper on the discovery in the journal *Science* was flabbergasted when we saw the material from Bedout. In a NASA-sponsored telephone press conference, researchers from several universities described the discovery of what appears to be the central ridge of an impact crater at Bedout, along with related meteor impact debris in India, Antarctica and Australia.

So big was the event that fossil evidence shows it wiping out 90 percent

of the species in the Earth's oceans and 70 percent of species on land. That startling fossil evidence of a massive die off caused early geologists to draw a line in the history of the Earth ending the Permian Period and commencing the Triassic Period. Columns of rock extracted from the Bedout site reveal that buried beneath more recent layers of ocean sediments is a 250-million-year-old meteorite impact crater. The smoking guns of an impact include such things as "shocked" quartz crystals, "glassified" feldspar crystals, pure silica glass and tiny bits of the meteorite itself. Shocked quartz are crystals of the mineral that are etched by the force of the impact, unlike all other quartz found on Earth. Glassified feldspars are crystals that look normal, until closer inspection reveals that they have been melted and quickly frozen again as non-crystalline glass, as might happen during and after an impact. The discovery of pure silica glass is another sure sign of a meteorite impact, said Poreda, because ordinary earthbound volcanic processes can't make glass of more than 85 percent silica.

Though the researchers are confident that the evidence points to a meteorite impact, they still have to fully nail down their hypothesis with more evidence and better dating of all the rocks. Over the next short period of time there will be more investigation to try and develop more evidence to support or refute this hypothesis.

Summary of story from Discovery News, May 13, 2004.

Dinosaur Bone Returns Home

Precious dinosaur remains – thought lost to science forever – are back in South Australia, 30 years after being discovered at Andamooka. The fossil shinbone from a small carnivorous dinosaur was dug up in opal beds in the early 1970's, but soon disappeared when it was sold on the private market. Three decades later, the SA Museum has tracked it down and is repairing the piece for display.

Honorary palaeontology curator Neville Pledge saw the bone soon after it was discovered and has since been on a mission to bring it home. About 5 years ago, a colleague read on a website that the bone was up for auction. The museum swung into action, negotiating with the vendor and raising the $22,000 to buy it, thanks to the Friends of the Museum and an anonymous donor. Last Easter, museum director Tim Flannery brought it back to SA.

Extract of story in the *Herald Sun*, May 2004.

Skull of *T. rex*, One of the Best

Researchers in the US have unveiled what they say is the most complete *Tyrannosaurus rex* skull ever discovered. Nicknamed Samson, the skull may challenge scientific beliefs about the dinosaur, said Chris Beard, curator of palaeontology at the Carnegie Museum of Natural History. About 30 *T. rex* skulls have been found worldwide, but most are incomplete or distorted by fossilisation, Samson appears to be almost complete and is undistorted and could be the most important *T. rex* skull ever collected. There is an enormous amount of scientifically important information to be gathered from this skull, which will keep researchers busy for a long time.

The skull was dug up on a South Dakota ranch in 1992 and acquired by businessman Graham Lacey. Mr. Lacey, who owns the skull, selected the Carnegie Museum to remove dirt and debris encasing the bones, a job which will take about 2 years.

Summary of story in *The Australian*, May 2004.

Thick-skulled Dinos Lose Their Head Butting Hard-nut Image

The popular image of dome-headed dinosaurs using their skulls as battering rams to fend off rivals may have to be revised. Pachycephalosaurs, or "thick headed dinosaurs", may not have been so hardheaded after all. Pachycephalosaurs' domed skulls were thought to have had a spongy radiating bone structure that seemed ideal for resisting compression forces, this led to the idea that the dinosaurs used their skulls as fighting weapons.

Now, Mark Goodwin, of the University of California at Berkeley, and John Horner, of Montana State University in Bozeman, have re-examined seven skulls from juveniles and adults of closely related pachycephalosaur species. Thin sections of the bone viewed under the microscope showed that the radiating structures only existed in young pachycephalosaurs (*Plaeobiology*, vol 30, p 253). The structures are absent in adult skulls where this head butting behaviour is presumed to have occurred. But dense, highly variable, specialised fibres found within the outer layer of the dinosaur's skull suggest that the skull had a substantial external covering. The researchers speculate that the ornament may have changed shape during life and been brightly coloured, acting as a visual signal, similar to the frills of *Triceratops*.

Summary of story from *New Scientist*, May 15, 2004.

New Dino 'Links Major Landmasses'

A cache of dinosaurs discovered in Niger may challenge our understanding of continental formation, US scientists have claimed. One of the dinosaurs - *Rugops* - was a wrinkle-faced carnivore, which lived about 95 million years ago. *Rugops* had relations in South America, indicating Africa became a separate continent later than thought, some researchers believe. The work is detailed in the Proceedings of the Royal Society of London.

Working in an area of the Sahara no bigger than a soccer field, Professor Paul Sereno and his team, from the University of Chicago U.S.A., dug up more dinosaurs from the late Cretaceous Period than the total previously found in Africa. "It was like the Valley of the Kings," said Professor Sereno, "except the kings were dinosaurs."

Of the material found, the most significant was the skull of *Rugops primus*, a peculiar-looking meat-eating dinosaur. Professor Sereno says the find is a key piece of evidence supporting his theory that Africa broke off from the rest of the super-continent Gondwana only about 100 million years ago, rather than over 120 million years ago, as scientists have previously suggested. *Rugops*, whose name means, "first wrinkle face", was about nine metres long with sharp teeth and a snout probably adapted for scavenging carrion.

The most interesting thing about *Rugops* is its ancestry, according to Professor Sereno. *Rugops* belonged to a group of southern dinosaurs called abelisaurids. Before Professor Sereno's discovery, abelisaurids from the same period had been found in South America, Madagascar and India, but not mainland Africa. Along with evidence from the sea floor, the bones of the wrinkle-faced dinosaur suggest that narrow land bridges continued to link the southern continents as recently as 95 million years ago, Professor Sereno believes.

Summary of story from BBC News Online, June 2, 2004.

Contender for Oldest True Animal

They are only 10 tiny fossils, found among 10,000 wafer-thin slices of ancient rocks, but scientists believe they could be the oldest true animals ever discovered. The fossils, found recently in southwest China, are known as "bilaterians" because they are creatures with

completely symmetrical, or bilateral, bodies, each with a front and rear, right and left sides, as all true animals have. Scientists estimate the creatures were alive between 580 million and 600 million years ago - more then 50 million years before the period known as the "Cambrian explosion," when within a few million years most of the major groups of animals first appear in the fossil record.

The microscopic oval-shaped creatures, looking like flattened turtle shells, are less than 180 microns long, barely the width of four human hairs. Each has a mouth, an anus, and a pair of pits in its body that could have been sense organs capable of detecting changes in its environment, like light or darkness, said David Bottjer of the University of Southern California, a member of the Chinese and American team that made the discovery. Their report is published in *Sciencexpress*, the online version of the journal *Science*.

If the newfound fossil organisms are indeed Earth's earliest known animals, then current views of the winding path of evolution will surely undergo new revisions, the scientists say. Six years ago, fossil hunters from the United States and Germany reported they had discovered "trace fossils" of long, sinuous burrows in the sandstones of central India. The burrows, they claimed, could have been made only by wormlike animals that lived at least 1.2 billion years ago - hundreds of millions of years before the organisms that Bottjer and his Chinese colleagues are reporting. Most scientists, however, have dismissed the "trace fossil" report as wishful thinking.

Kevin Peterson, a Dartmouth biologist and expert on the early evolution of animal body plans, recently reported that by using a "molecular clock" to track the average mutation rates of well-dated fossils and their modern descendants, he and his colleagues place the emergence of the first common ancestors of the bilaterian organisms at between 573 million and 656 million years ago. Peterson, whose work was published in April 2004, in the *Proceedings of the National Academy of Sciences*, said in an interview that his dates appear "right on target" with the dates that Bottjer and his colleagues have assigned to their fossils.

Bottjer and Jun-Yuan Chen, of the Nanjing Institute of Geology and Paleontology, the report's lead authors, note that the oldest common ancestors of their fossil creatures, perhaps millions of years earlier, must have already possessed a complex genetic "tool kit" to yield the

complex structures of the animals they found. The scientists have named their fossil animals *Vernanimalcula guizhouena*. The genus name means "small spring animal" in Latin; the species name refers to the area where the fossils were found, once a seabed among the rolling hills, rice farms and the phosphate quarries of China's Guizhou province. "Spring" refers to the time some 600 million years ago when a major worldwide glaciation ended. Under the controversial "Snowball Earth" theory, this period gave way to a later era of warming that may have lasted for many millions of years.

Summary of story from the *San Francisco Chronicle*, June 3, 2004.

Fossil Police Bare Their Teeth

Fossils and dinosaur eggs up to 150 million years old have been seized by Australian Federal Police during a raid on three properties in Western Australia. The 1300 Chinese fossils are valued at more than $5 million, making the haul the largest ever in Australia. Included in the 20 tonne seizure are fossils of dinosaurs, fish, tortoises and rhino skulls. The director of the Movable Cultural Heritage Unit of the Department of Environment and Heritage, Kevin Wohlers, said the haul was very large in global terms.

The fossils were discovered when Australian Federal Police officers raided a home and two businesses at Mandurah, south of Perth. When the Federal Police investigation has been completed, the matter will be referred to the Director of Public Prosecutions for consideration. Other investigations are also being conducted nationwide as the result of a request for help from Chinese authorities in June 2003. Australia and China are signatories to a UNESCO convention prohibiting illicit trade in fossils. Anyone convicted of illegally importing fossils faces a maximum fine of $100,000 per item, or five years in jail, while Corporations can be fined a maximum of $200,000 per item.

Since the items were seized, they have been inspected be expert palaeontologists from the WA Museum. John Long, Curator of Vertebrate Palaeontology, from the WA Museum was “totally staggered” to see such a large collection in WA. It is expected the fossils will be returned to China once legal formalities have been completed. Most are from the Chinese province of Laioning – regarded as one of the best spots in the world for palaeontological research.

Summary of story from the *Herald Sun*, June 18, 2004.

Spanish Dig Yields New Dino Cache

Palaeontologists in northern Spain have discovered numerous new dinosaur bones at a site that recently yielded the remains of Europe's biggest dinosaur. The new remains from Riodeva include a fossil pelvic bone of a large sauropod dinosaur that was related to the group *Diplodocus*. A new park was recently opened near the dig site to show off the bones to the public. The new cache of fossils also includes the bones of stegosaurs, famous for the plates that lined their backs.

Luis Alcala, director of the Palaeontological Foundation of Teruel, said the new cache contained the remains of sauropods, stegosaurs and also of carnivorous dinosaurs, along with the remains of crocodilians. He said there were already suggestions the new remains could yield some surprises, but at this stage would not make any further comment.

The pelvic bone - a right ilium - belongs to a diplodocid, the family of dinosaurs that includes the famous sauropod *Diplodocus*. Dr Alcala presented the Cretaceous Period fossil at the 6th Geological Congress of Spain in Zaragoza this past July.

In 2003, palaeontologists Alberto Cobos and Rafael Royo discovered bones at Riodeva that would later be shown to belong to a 35 m long sauropod weighting 50 tonnes. The huge sauropod was the largest dinosaur yet found in Europe. But the researchers have not yet classified it taxonomically. It could belong to a new species, or could be related to a group that is already recognised such as *Argentinasaurus*. Dr. Alcala speculates there is still several more years' work to be done at the Riodeva site and can only wonder at what else might be found.

Summary of story from BBC News Online, July 20, 2004.

Career of Dino 'Inventor' Marked

London's Natural History Museum (NHM), one of the top UK scientific establishments and tourist attractions, is celebrating the bicentenary of Sir Richard Owen. The controversial Victorian founded the NHM in 1881 after a 25-year campaign. Designed by Alfred Waterhouse, Owen's "cathedral to nature", with its arched galleries and terracotta carvings, has become a major city landmark. Sir Richard was one of the first to recognise the importance of a group of extinct reptiles he called

Dinosauria. He is also credited with being the first scientist to describe in detail the flightless dodo bird *Raphus cucullatus*.

But this great establishment figure was also somewhat notorious, accused of stealing other scientists' specimens and undermining people by writing anonymous reviews of their work while supporting them in public. Owen's contemporary and rival Gideon Mantell described him as "overpaid, over-praised and cursed with a jealous monopolising spirit." There was undoubtedly envy - he was so prestigious and so good at what he did that many of his contemporaries just couldn't bear to see him being so successful. But the other thing is that he was a very aggressive, pompous individual. He used to go and gazump people when they were trying to acquire fossil collections. He would get in there very quickly and take them out from under their noses.

Despite this reputation, few could deny his genius. In 1839 he published the first identification of the moa, from New Zealand - another extinct, flightless bird. Owen received a small, 15 cm fragment of leg bone from a large flightless bird, he didn't know that at the time but assumed it and staked his whole reputation on the fact that these birds would be discovered on New Zealand. This turned out to be the case when just a few years later, complete specimens were found.

The NHM is running a display called Richard Owen - The Man Who Invented Dinosaurs. It describes many of his discoveries and displays artifacts that played a significant role in his remarkable story. The original moa bone Owen worked on will be on show for the first time since the Natural History Museum opened in 1881. Included in the display of other specimens he worked on is *Diprotodon*, the largest marsupial that ever lived; and the tiny horse ancestor *Equus curvidens*, a dog-sized ancestor to modern horses.

But it is the dino connection for which Sir Richard Owen will be best remembered. He was commissioned by the British Association to write a report on all the fragmentary reptilian remains found in southern England in the early 19th Century. In doing that he recognised that some of these fossil reptiles were rather special, actually much more mammal-like in their anatomy than all the other reptiles he was familiar with. He used those features to link together three animals to form this amazing group, the dinosaurs, which he named the 'terrible lizards', largely on the basis of their enormous size. Richard Owen oversaw the construction of the first ever full-size dinosaur models and when they

went on display in 1854, Victorian Britain was struck with the first ever outbreak of "dinomania".

Summary of story from BBC News Online, July 20, 2004.

Dinosaur Era Bird Could Fly, Brain Study Says

The earliest known bird was discovered in a Bavarian quarry in 1861. Ever since, scientists have disagreed as to whether *Archaeopteryx* was fully capable of flight. Exquisitely preserved fossils reveal that the winged, feathered animal had numerous modern birdlike features, but much of its primitive reptilian skeleton betrays a close kinship to meat-eating dinosaurs. Now a study into the shape of *Archaeopteryx's* brain says that the animal already possessed many of the prerequisites for flight, such as great vision and a good sense of balance - traits all birds share today.

The analysis, which was detailed in the science journal *Nature,* provides some of the best evidence yet that *Archaeopteryx* spent much of its time on the wing. To fly *Archaeopteryx* needed a very sophisticated coordination-and-control command center, the new study shows that the brain and sensory systems of *Archaeopteryx* were fully equipped for flight.

Archaeopteryx was discovered shortly after the publication of Charles Darwin's *Origin of Species* (1859). In the book, Darwin described his theory of evolution by natural selection. Considered a bird, 147-million-year-old *Archaeopteryx* nevertheless seems to be a halfway house between birds and dinosaurs. Since Victorian times, it has been taken as one of the icons of evolution in action. Like a bird, *Archaeopteryx* had feathered wings, but it also had a cumbersome bony tail and lacked the large breastbone (and therefore the wing-powering mass of muscle on its chest) that are characteristic avian traits.

Some experts have argued that the animal used its wings to hop and scrabble about in trees rather than for powered flight. However, "the majority of scientists now accept that it could get airborne," said fossil-anatomy expert Larry Witmer of Ohio University's College of Osteopathic Medicine. Witmer is the author of an accompanying commentary that was also published in *Nature*. The question is, once it was airborne, was it just a glider, a weakly flapping flyer, or a strong flyer?

To answer this question, Angela Milner, of The Natural History Museum, London, joined Patricio Dominguez Alonso, of Universidad Complutense de Madrid in Spain, and other colleagues. They applied modern imaging techniques to the first discovered *Archaeopteryx* fossil. One of just six in existence, the specimen is housed in the Natural History Museum. The team used x-ray technology called computed tomography. In this technique a computer combines a series of flat cross-sectional images to create a three-dimensional model of a body structure. The process allowed Milner and her colleagues to look inside the animal's tiny braincase and make a 3-D reconstruction of its brain and inner ear.

Earlier, Witmer and others had performed a similar study on fossils of the flying reptiles called pterodactyls, which are not related to *Archaeopteryx*. Published last year in *Nature,* the pterodactyl study showed that these reptiles had many of the same brain features as modern birds. The report suggested that certain brain features are minimum requirements for the development of flight.

The new analysis by Milner and her colleagues shows for the first time that *Archaeopteryx*'s brain had many of the features that birds use to hone their flying abilities today. *Archaeopteryx*'s brain was smaller, in proportion to its body size, than the average bird brain today. The ancient creature's brain, though, was around three times as big as the brains of comparably sized reptiles of the same time period. Furthermore, the way *Archaeopteryx*'s brain was organized was also very birdlike, according to the study. The cerebral hemispheres and other parts of the brain involved with vision and movement were relatively large. And the size and shape of *Archaeopteryx*'s inner ear hint that the animal had a keen sense of balance and spatial awareness. Though less sophisticated than modern birds, *Archaeopteryx* appears to have had all the neurosensory mechanisms necessary for flight; it probably wasn't an endurance flyer but was certainly capable of proper, powered, flapping flight.

Finding that the brain is so sophisticated in this species is surprising. Though *Archaeopteryx* is the oldest bird known from the fossil record, the discovery suggests that flight must have begun long before and therefore much further back in time than expected. Ground-dwelling animals live for the most part in two-dimensional space, but flying animals live very much in three dimensions, so the ability to sense

your position in space and use that information to make constant adjustments needs to be very well developed. These pressures lead to the development of certain parts of the brain in both birds and pterodactyls.

Analyzing the brains of some meat-eating dinosaurs for similarities to *Archaeopteryx's* brain may allow researchers to test a highly controversial theory that some dinosaurs are the "secondarily flightless" descendents of *Archaeopteryx*. Some researchers have suggested that *Archaeopteryx* could in fact be the ancestor of a group of dinosaurs that includes velociraptors. Those carnivores have many similarities to *Archaeopteryx* but appear later in the fossil record. The study by Milner and her co-authors will now allow researchers to tease apart the transition between birds and dinosaurs in a whole new way.

Summary of story from *National Geographic News*, August 4, 2004.

Early fish Hit Land to be Better Predators

Our distant fishy ancestors first hauled themselves on to land in order to warm up in the Sun. So claims a team that says basking would have provided an energy boost that made the fish more agile in the water, improving their chances of snaring prey. It was also an evolutionary milestone that heralded the rise of all land vertebrates, including us. Numerous explanations have been put forward to explain why a group of primitive fish decided to drag themselves out of the tropical Devonian swamps on to dry land some 365 million years ago. Some say it allowed them to escape predators or putrid, shrinking pools during drought, while others have suggested it allowed them to scavenge stranded fish.

Now Robert Carroll, from McGill University in Montreal, Canada, and his colleagues suggest the transition was all about becoming a better predator in water. The team used fossil record information about the bodies of early tetrapods - the fish-like animals that crawled on to land - and the tropical conditions at the time to work out how much solar energy they could have absorbed. They predict a typical tetrapod could have warmed up to 35 °C in two to three hours.

The tetrapods didn't have to eat to get energy, they just basked in the sun which, at a stroke doubles metabolic processes, making the animals much more nimble in the water. And Carroll points out that crocodiles adopt a very similar strategy of basking before slipping into the depths.

The researchers have published their work in the *Zoological Journal of the Linnaean Society.*

Jenny Clack, an expert on early tetrapods at Cambridge University, UK, says she was sceptical of the idea at first, but now thinks it is plausible. But she doubts that a tetrapod would have to come right out of the water to gain the benefits.

Summary of story from *New Scientist*, August 3, 2004.

Teenage T. rex's Monstrous Growth

Tyrannosaurus rex achieved its massive size due to an enormous growth spurt during its adolescent years. US researchers say the carnivorous dinosaur's enlargement resulted in a monster weight gain of up to 2.07 kg per day over four years. The team analysed bones from 20 specimens of tyrannosaur (the group of dinosaurs to which *T. rex* belongs) to reconstruct their growth histories. Details of the work have been published in the science journal *Nature*.

Gregory M Erickson of Florida State University and his colleagues used growth lines on fossilised bones to estimate the ages of the dinosaurs they came from. They then measured the circumference of the bones and used both sets of data to generate growth curves for the creatures. The results showed that *T.rex* had a maximum weight gain of 2.07 kg between the ages of about 14 and 18 years, allowing it to reach maturity in two decades, after this, the dinosaur's growth settled down. The accelerated spurt could result in a total gain of 3,000 kg. *Tyrannosaurus rex* weighed around 5,000 kg - sometimes more - and lived for up to 28 years.

Until now, two theories had been proposed to explain the gigantic size of *T. rex*. Either it grew faster than its tyrannosaur relatives or it grew for a longer period of time. In addition to *Tyrannosaurus rex*, the researchers also studied bones from three other species of dinosaur: *Albertosaurus sarcophagus*, *Gorgosaurus libratus*, and *Daspletosaurus torosus*. The scientists found that these dinosaurs had maximum growth spurts ranging from 0.31 kg to 0.48 kg per day. Like their relative *T.rex*, they could keep this spurt up for four years. But because they were gaining significantly less weight per day, their growth spurts failed to keep up with those of *T. rex*, which went on to outgrow all its tyrannosaur relatives.

Summary of story from BBC News Online, July 20, 2004.